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(72) Inventor JOHN EDWARD TAYLOR



(54) METHOD OF MODIFYING THE PHYSICAL
PROPERTIES OF WATER-HARDENABLE
COMPOSITIONS

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(71) We, JOHN LAING AND SON LIMITED, a British Company, of 133/139 Page Street, Mill Hill, London, NW7 2ER, do hereby declare the invention, for which we pray that a patent may be granted to us; and the method by which it is to be performed, to be particularly described in and by the following statement:—

The invention relates to a method for modifying the properties of water-hardenable compositions, particularly though not exclusively concretes, mortars and the like, by the addition of additives comprising fibres, fibrous or fibrillated material and agents adapted to modify the physical properties of the compositions.

Considerable research has gone into the study of agents and additives intended to alter the physical properties of cements, concretes and mortars. As a result of such research it has been proposed to use as one such additive the combination of fibrous material and a modifying agent such, for example, as an air entraining agent (see, for example, B.P.S. No. 1,285,701 assigned to the assignee of the present application). Heretofore, such additives have normally been added separately to the concrete mix and together they have been shown to drastically alter the rheological properties of the plastic mix.

In the prior art proposals the fibres are usually added either as discrete cut lengths sprinkled by hand or by various devices whose object is to separate the fibres and prevent felting, or they may be cut as required by means of a fibre cutter dispenser.

Amongst the problems encountered in the production of water-hardenable compositions, such as concretes and mortars, containing such additives the separating of the fibres to prevent felting thereof and of ensuring a satisfactory dispersion of the additive throughout the composition during mixing thereof, whilst ensuring that the cost of the equipment required for dispersing the modifying agent and the additive throughout the composition

does not become prohibitive, have presented most difficulty.

It is an object of the present invention to provide a simple and economical method of altering the physical properties of water hardenable compositions such as concrete amongst which properties may be noted, for example, the setting and/or hardening time, plasticity, workability, durability, water-proofing, frost resistance, resistance to physical or chemical attack, air-entrainment, shrinkage, hardness, density, colour, permeability, strength, thermal transmittance, and sound attenuation of the composition.

According to the invention there is provided a method of modifying the physical properties of a water-hardenable composition containing Portland cement or high alumina cement as hydraulic binding agent which comprises adding to the composition a modifying material comprising a fibrous material the fibres of which are coated or impregnated with and bound together by a dry water-soluble or dry water-dispersible modifying agent capable of modifying the physical properties of the water-hardenable composition; and subjecting the mixture to a mixing operation to thoroughly and separately disperse the modifying agent and the fibres of the fibrous material throughout the composition.

The modifying material used in accordance with the invention is suitably provided by impregnating or coating the outer surfaces of the fibrous material (which term is also intended to cover fibrillated material) with a solution or suspension of at least one modifying agent then drying the coated or impregnated material thereby to bind the fibres of the fibrous material with the modifying agent.

The invention enables the modifying material to be packaged in suitable pre-determined dosages containing specified amounts of each constituent ready to be simply added to a water hardenable composition such as a concrete or mortar mix to produce a composition having its properties modified in a

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specified and desired manner. In the case of batch mixing of a water hardenable composition, for example, a concrete or mortar mix, this prepackaged dosage thus enables a greater degree of control to be had over the ingredients in the mix than is possible when reliance has to be placed on an operator calculating and adding to the composition the amounts of fibrous material and modifying agent or agents required to produce a composition having the desired characteristics.

The agents for modifying the physical properties of concrete suitable for use in this invention can be any material which enhances or alters a physical property of their composition; suitable agents for these purposes include, by way of example: as setting and/or hardening agents water-soluble chlorides, carbonates, silicates, silicofluorides, hydroxides and borates, triethanolamines and sugars, lignosulphonic acids and their salts, hydrocarboxylic acids and their salts: as plasticizers—surfactants, and ionogenic, cationogenic and non-ionogenic synthetic resins, e.g. polymethylacrylic acid and copolymers of vinyl acetate, maleic acid anhydride, polyvinyl alcohol, polyvinyl acetate; as waterproofers—alkali metalcalcium-, zinc- and sodium-soaps, oleic acids, inorganic salts of fatty acids; as air entraining agents—saponified wood resins which may or may not be stabilised with animal glue, other saponified resin, such as that sold under the trade mark Vinsol (R.T.M.), the sodium salts of certain aliphatic and aromatic sulphates for example sodium lauryl sulphate, sodium cetyl sulphate, sodium oleyl sulphate and sodium naphthalene isopropyl sulphate, certain sulphates of petroleum derivatives, and certain complex organic compounds, for example, keratin and saponin. Other agents for modifying the durability, the shrinkage, the frost resistance, the resistance to physical or chemical attack, may also be incorporated in accordance with this invention.

It is a feature of this invention that the modifying agent incorporated with or present on the surface of the fibres passes into the water hardenable matrix with the water initially incorporated into the composition. The modifying agent thus becomes available at the beginning of the mixing cycle and will produce a suitably modified composition such, for example, as an air entrained fibrous concrete.

The modifying material utilised in this invention may comprise any fibrous material which does not chemically react initially with the chemicals present in the water hardenable composition or with the modifying agent. The additive may be composed of organic fibres such as polypropylene, nylon, sisal, and cotton and certain inorganic fibres such as glass, ceramic fibres and metals.

The fibres may be of any convenient length, but preferably between about 0.5 cm and 3 cm.

One method of coating the fibres would be to dip the fibres in a solution of the modifying agent and remove by evaporation the solvent or vehicle containing the agent. The modifying agent may be soluble in the vehicle liquid or can be carried in a finely divided state in liquid suspension or by any other convenient means.

Preferably the additive may be prepared by impregnating a long rope, formed from a plurality of fibres, with the modifying agent carried in solution or suspension. The modifying agent after removal of the solution vehicle acts as a binding agent for the fibres so that they can be cut into short bundles for incorporating into the water hardenable mix. The combination of the water present in the fresh composition and the mechanical action of the components of the composition dissolve or suspend the modifying agent and disperse the fibres throughout the composition i.e. whilst the water in the composition serves to dissolve or suspend the modifying agent, this process being assisted by the mechanical mixing action. The water hardenable composition the property of which is to be modified with the admixtures according to this invention may be any water hardenable mass incorporating as hydraulic binder Portland cement or high alumina cement.

As one example, an admixture was prepared by impregnating a long rope, consisting of a large number of polypropylene fibres, with a concentrated solution of the sodium salt of a wood resin Vinsol (R.T.M.) and drying at 50°C in an oven.

The now rigid rope was then cut into 2 cm lengths with a sharp blade, the cylindrical bundles of fibres remaining intact. The ratio by weight of fibres to resin was determined as 3:1.

A fibrous air entrained concrete was now prepared consisting of the following proportions:—

Ordinary Portland Cement	1.00 part by weight
Aggregate	3.00 parts by weight
water	0.42 parts by weight
Admixture prepared as above	1 gm per 75 gms cement

Mixing in a conventional concrete mixer produced a highly air entrained concrete evenly dispersed with fibres.

In another example, a formulation was prepared exactly as in the foregoing example, but substituting a mixture of equal parts by weight of sodium stearate and polyvinyl alcohol for the Vinsol (R.T.M.) resin men-

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tioned therein thereby producing a waterproof, plastic fibrous concrete.

WHAT WE CLAIM IS:—

1. A method of modifying the physical properties of a water-hardenable composition containing Portland cement or high alumina cement as hydraulic binding agent which comprises adding to the composition a modifying material comprising a fibrous material the fibres of which are coated or impregnated with and bound together by a dry, water-soluble or dry, water-dispersible modifying agent capable of modifying the physical properties of the water-hardenable composition; and subjecting the mixture to a mixing operation to thoroughly and separately disperse the modifying agent and the fibres of fibrous material throughout the composition.
2. A method as claimed in claim 1 in which the modifying material is prepared by impregnating or coating the fibrous material with a solution or dispersion of the modifying agent and drying the coated or impregnated fibrous material.
3. A method as claimed in any one of the preceding claims in which the modifying material is prepackaged in pre-determined dosages containing specified amounts of each constituent.
4. A method as claimed in any one of the preceding claims wherein the modifying material is prepared by impregnating a long rope, formed from a plurality of fibres, with the modifying agent carried in solution or suspension, removing the solution vehicle so that the modifying agent acts as a binding agent for the fibres and cutting the resultant bound fibres into short bundles for incorporation into the composition.
5. A method as claimed in any one of the preceding claims wherein the modifying agent comprises a setting and/or hardening agent.
6. A method as claimed in claim 5 wherein said setting and/or hardening agent is selected from among soluble chlorides, carbonates, silicates, silicofluorides, hydroxides and borates, triethanolamines and sugars, ligno-sulphonic acids and their salts and hydro-carboxylic acids and their salts.

7. A method as claimed in any one of the preceding claims wherein the modifying agent comprises a plasticizer.

8. A method as claimed in claim 7 wherein said plasticizer is selected from among surfactants, and ionogenic, cationogenic and non-ionogenic synthetic resins.

9. A method as claimed in claim 8 wherein said non-ionogenic synthetic resins are selected from among polyacrylonitrile, polymethylacrylic acid, copolymers of vinyl acetate maleic acid anhydride and isobutylene maleic acid anhydride, polyvinyl alcohol, and polyvinyl acetate.

10. A method as claimed in any one of the preceding claims wherein the modifying agent comprises a waterproofing agent.

11. A method as claimed in claim 1 wherein said waterproofing agent is selected from among alkali metal-, calcium-, zinc- and sodium-soaps, oleic acids, and inorganic salts of fatty acids.

12. A method as claimed in any one of the preceding claims wherein the modifying agent comprises an air entraining agent.

13. A method as claimed in claim 12 wherein said air entraining agent is selected from among saponified wood resins, other saponified resin, the sodium salts of aliphatic and aromatic sulphates selected from among sodium lauryl sulphate, sodium cetyl sulphate, sodium oleyl sulphate and sodium naphthalene isopropyl sulphate, keratin and saponin.

14. A method as claimed in claim 13 wherein said saponified wood resins are stabilised with animal glue.

15. A method as claimed in any one of the preceding claims wherein said fibres are selected from among organic fibres such as polypropylene, nylon, sisal and cotton, and inorganic fibres selected from among glass, ceramic fibres and metals.

16. A method as claimed in any one of the preceding claims wherein said fibres have a length of between 0.5 cm and 3 cm.

17. A method as claimed in claim 1 substantially as hereinbefore described.

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